MEBT Steering Coil Thermal Test

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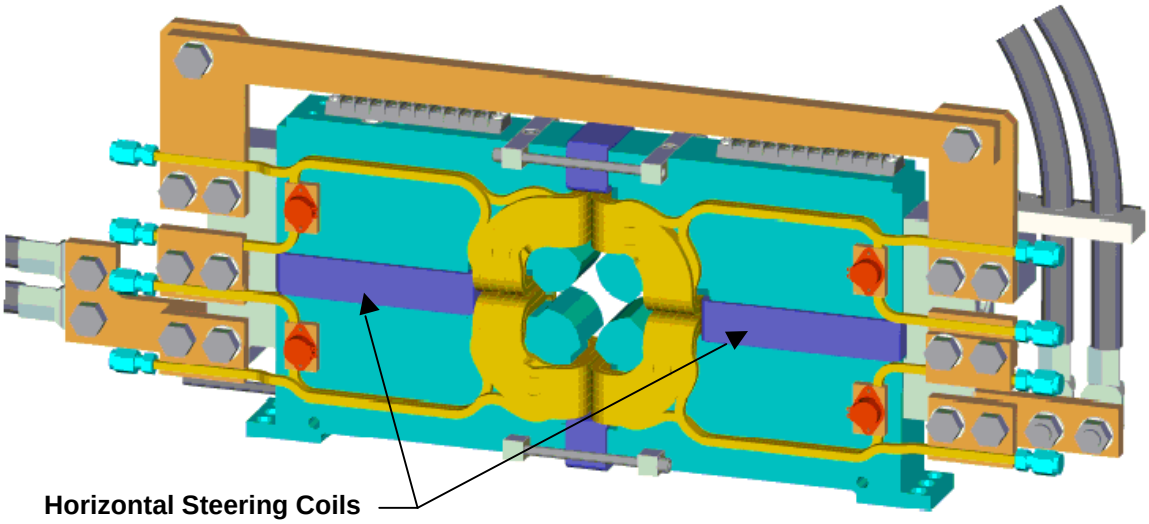
Summary
A test was performed to determine the operating temperature of the MEBT Quadrupole Steering Coils. A prototype horizontal steering coil was wound with alumina filled, high thermal conductivity epoxy (see FE-ME-013A). Because the coils will be cooled mainly through conduction to the steel core of the magnet, the coil was mounted on a representative piece of steel. Temperature measurements were made with two thermocouple probes (type K) on the outside and inside of the coil.

Typical MEBT Quadrupole Magnet with Steering Coils



Discussion
The internal dimensions of the prototype coil were approximately .020" larger than than the maximum specified dimensions for the production coils. This resulted in a larger gap between the coil and the steel on two sides. Temperatures measured on the sides with gaps were routinely higher than those measured on the sides which were in close contact with the steel. This observation confirmed the prediction that heat conduction to the core, rather than free convection, would be the primary cooling mechanism.

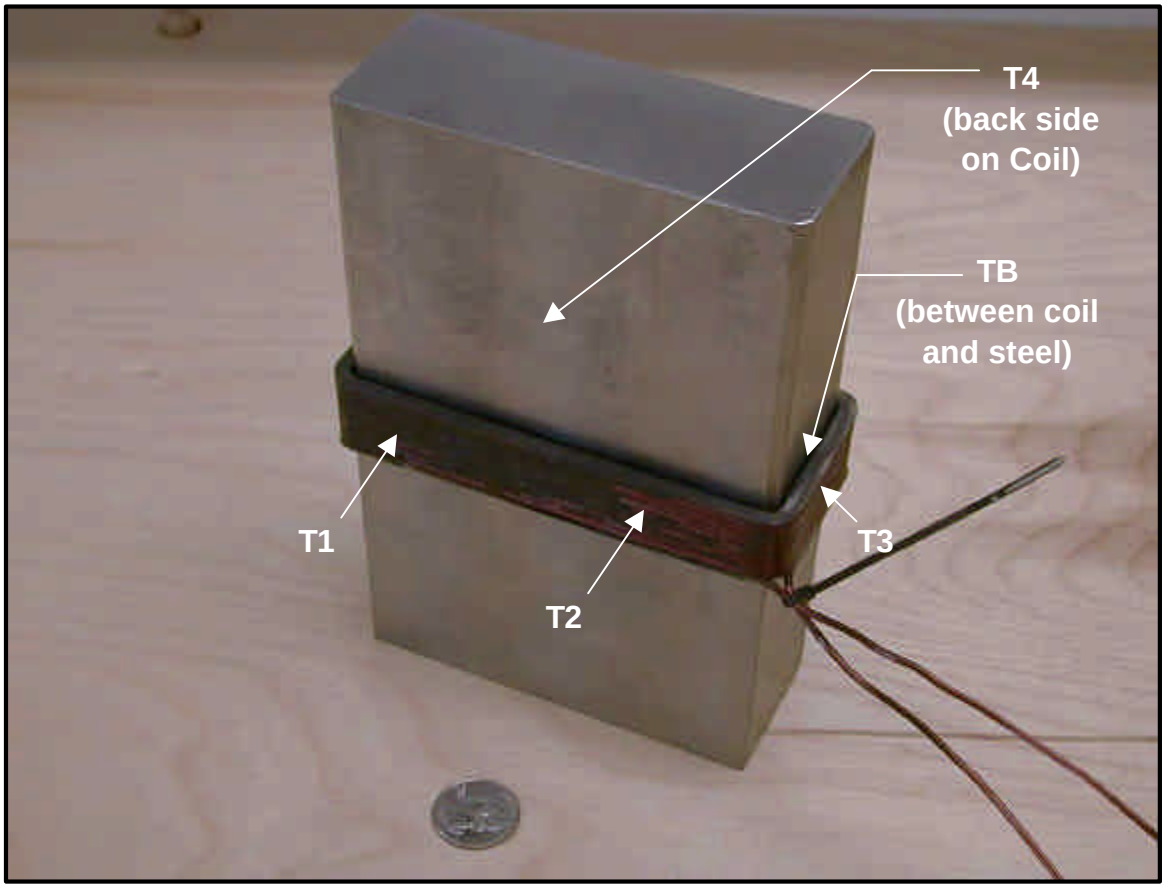
Results
The coil was run at its nominal operating current, 6 Amps, then 12 Amps and 18 Amps. At its nominal operating current, the coil reached a temperature of 76 °F (a few degrees above the ambient temperature of 72 °F). At 18 Amps. The coil reached a maximum temperature of around 117 °F These measurements suggest that the coils could operate at three times their nominal current with out compromising the integrity of the epoxy which is rated up to 392 °F. This allows for the possibility of operating the coils at a higher current than currently anticipated, creating larger steering angles.

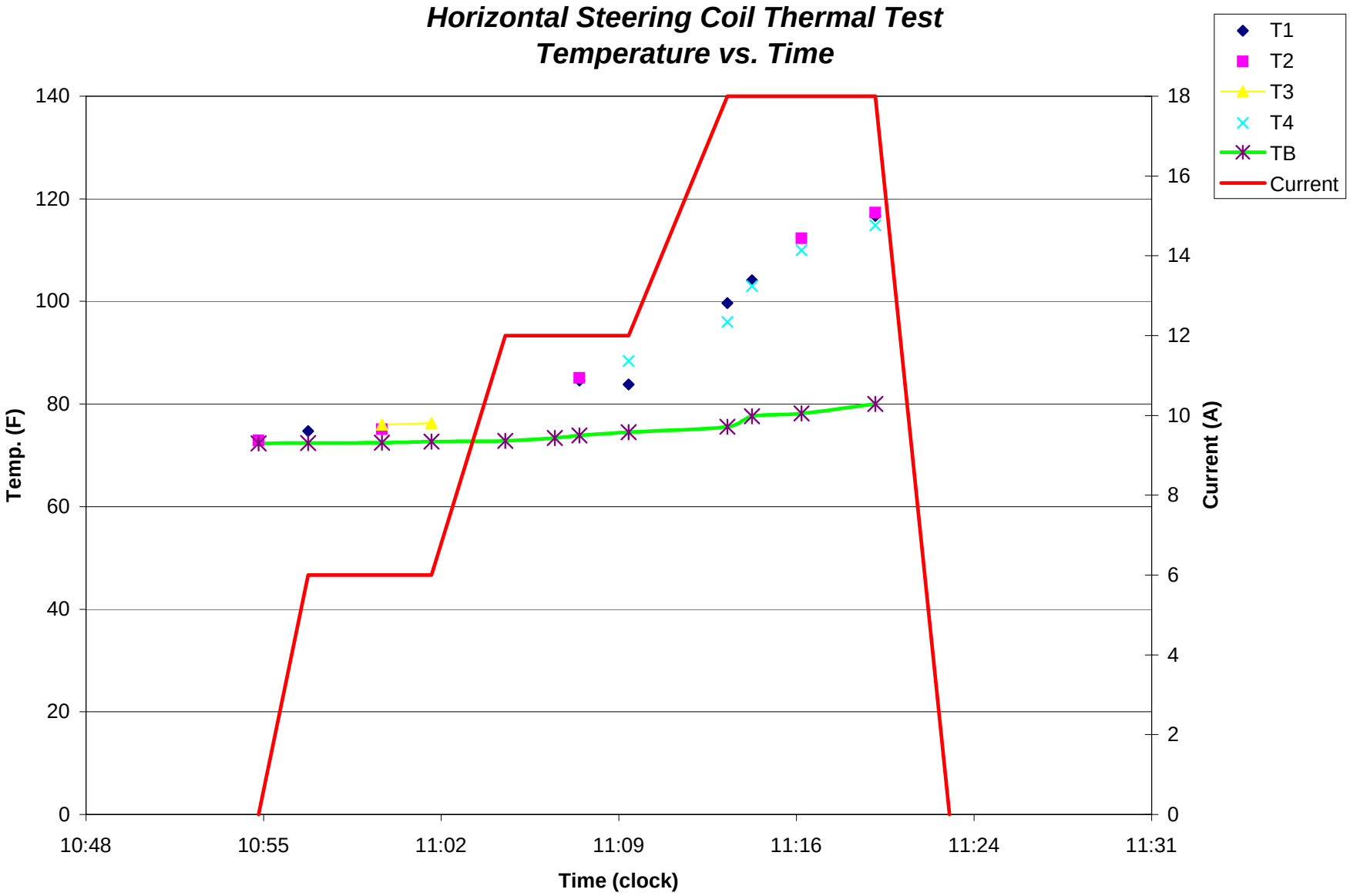
Horizontal Steering Coil Thermal Test Data (3/31/00)

Measurment	Time (clock)	Current (Amp)	T1 (F)	T2 (F)	T3 (F)	T4 (F)	TB (F)
1	10:55	0	72.9	72.9			72.3
2	10:57	6	74.7				72.4
3	11:00	6	75.2	75.1	76		72.5
4	11:02	6			76.3		72.7
5	11:05	12					72.8
6	11:07	12					73.4
7	11:08	12	84.6	85.1			73.9
8	11:10	12	83.8			88.4	74.5
9	11:14	18	99.7			96	75.6
10	11:15	18	104.1			103	77.6
11	11:17	18		112.3		110	78.2
12	11:20	18	116.7	117.3		114.8	80
13	11:23	0					

Measured Inductance (1kHz)

L =	70.0 µH	Free
L =	144 µH	On steel





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